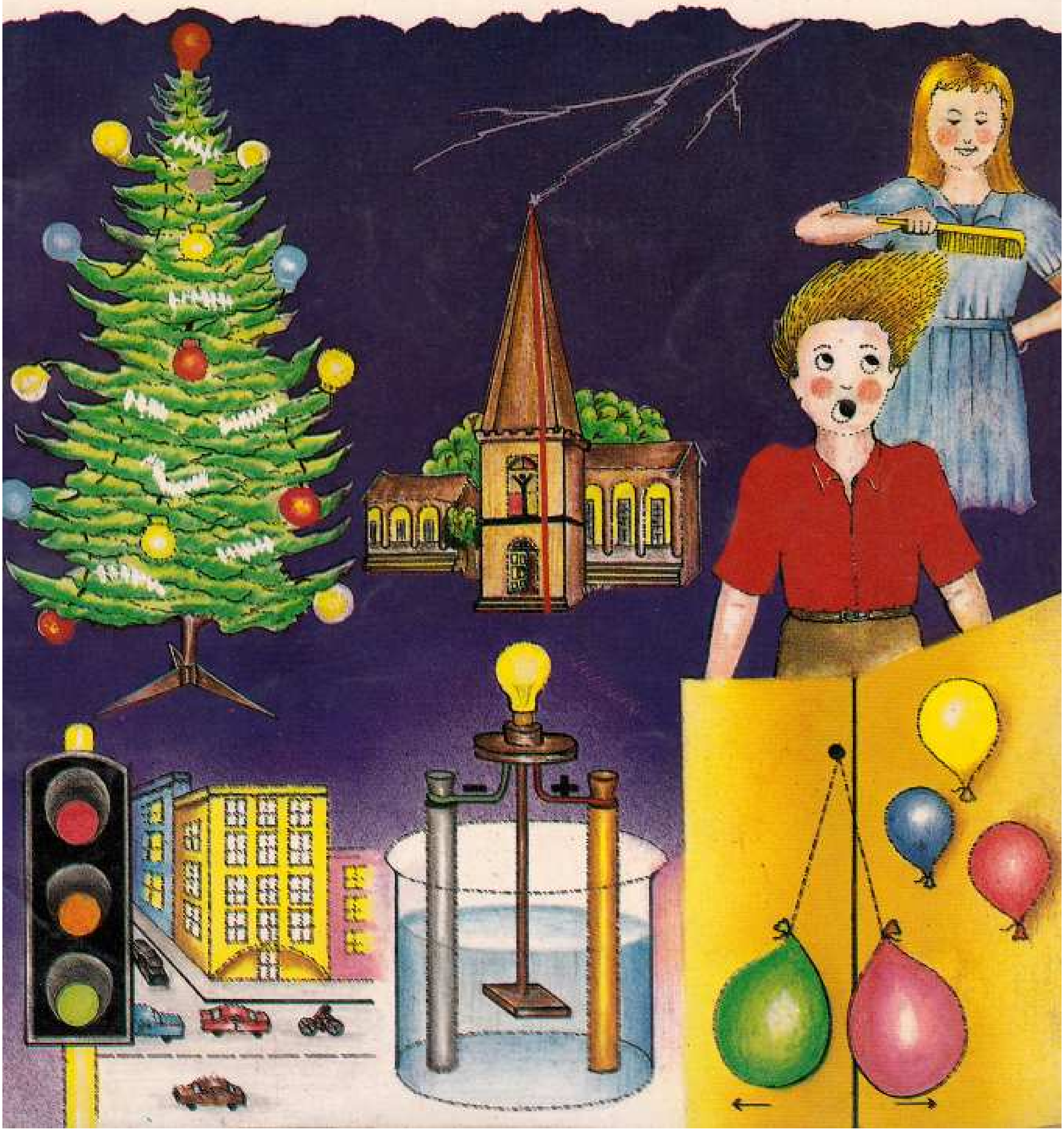
LET'S EXPERIMENT WITH

ELECTRICITY

THE LEARNERS WAY



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THE LEARNERS WAY

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LEARNERS PRESS

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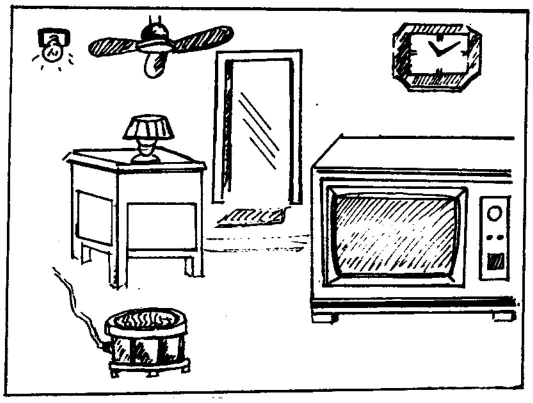
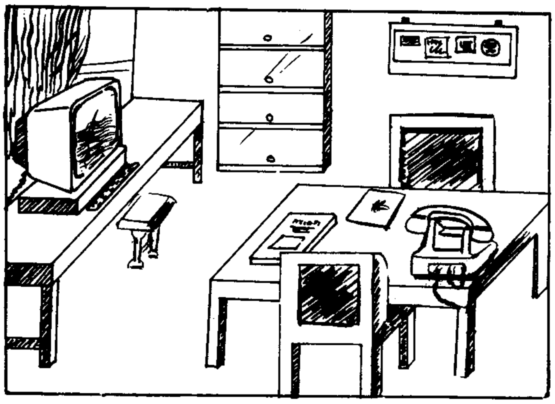
One
WHAT IS ELECTRICITY?

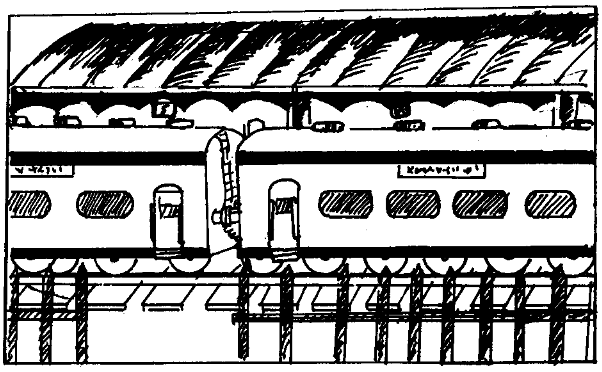
Electricity is our greatest friend. At home, it lights bulbs, moves fans, pumps water and works household gadgets.





In offices and factories it operates lifts, runs huge machines and produces all sorts of goods for us. It carries messages instantly from one corner of the world to another through telephones, telegraphs, faxes and computers.

It lights the streets and runs trains. It entertains us through movies and televisions.



Have you seen electricity?

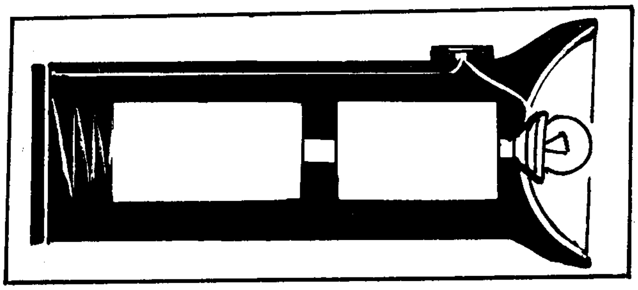
Electricity cannot be seen. We can only see the effects it produces.

* Have you seen lightning flash across the sky? Lightning is caused by electricity present in storm clouds.

* Did you ever notice tiny sparks and hear crackles while taking off a nylon sweater in a dark room? Both the sparks and the sound are produced by the electricity in your nylon sweater.

* Comb your hair with a plastic comb and hold it near small pieces of paper. What do you find? The pieces of paper are attracted by the electricity in your comb.

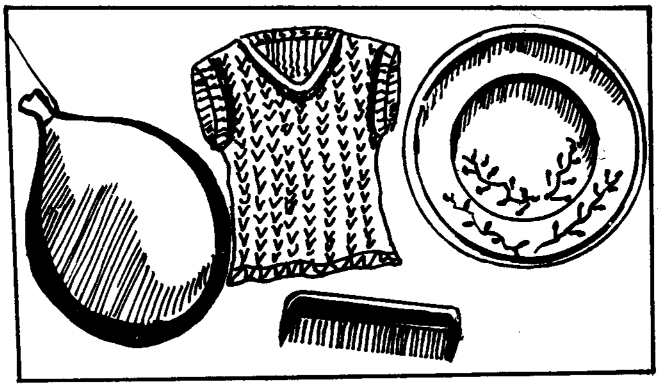
* When you switch on a torch, the bulb glows. It is the effect of the electricity produced by the batteries in your torch.

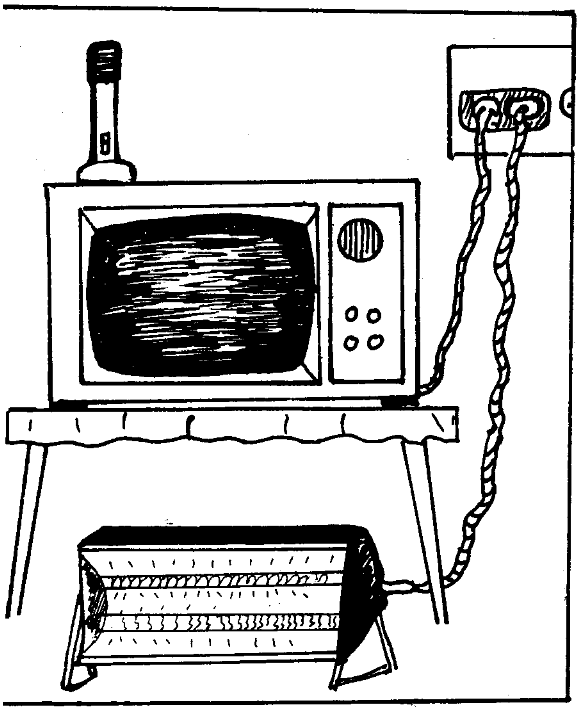


* Switch a fan on. The blades move due to the electricity supplied to the wires in your house.

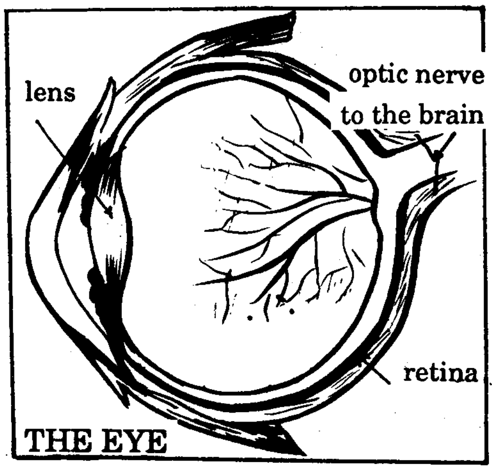
There are two kinds of electricity

The electricity that causes lightning, sparks, crackling noises and attracts objects, and is contained in things like storm clouds, nylon and plastic, is called *static electricity*. Static electricity can be got by rubbing things together and is called static because it cannot move on its own.





Electricity that flows through wires and does work for us, like lighting a torch or working a fan, is called *current electricity*. Current electricity is produced by batteries or by generators in power plants and is supplied to homes.



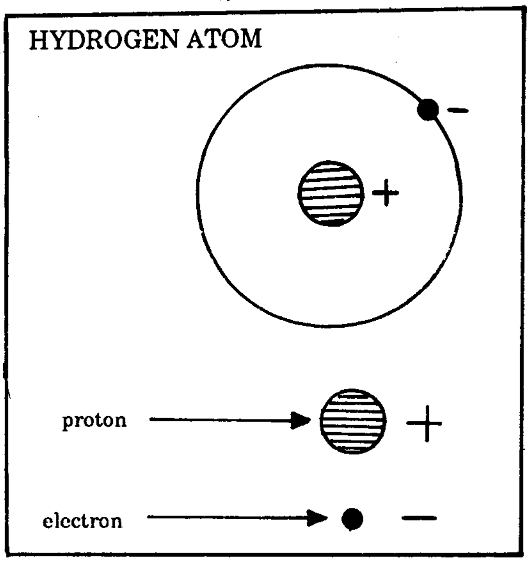
An interesting fact

Small currents are constantly flowing through our nerves. When you see something, an image of that object forms at the back of your eye. The optic nerves carry this information from the eye to your brain in the form of a current. Only then do you realize what you 'see'. Our body muscles, too, are controlled by the flow of electrical currents from the brain down to the nerves of the muscles.

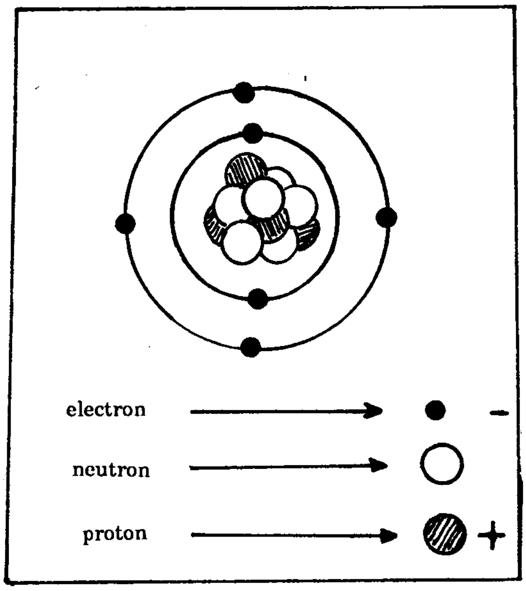
Do all things contain electricity? To know, let us take a closer look at the *structure of things.*

If we keep breaking a piece of iron, say, into smaller and smaller pieces, we would ultimately be left with a single unit of iron called an iron atom. Like iron, all things are made of atoms.

Atoms are too tiny to be seen. Atoms contain even tinier particles called neutrons, protons and electrons. Neutrons and protons form the central core of atoms around which electrons keep circling.



The simplest atom is the hydrogen atom. It has one electron and one proton. Some atoms can be really complex.



CARBON ATOM

6 protons

6 neutrons

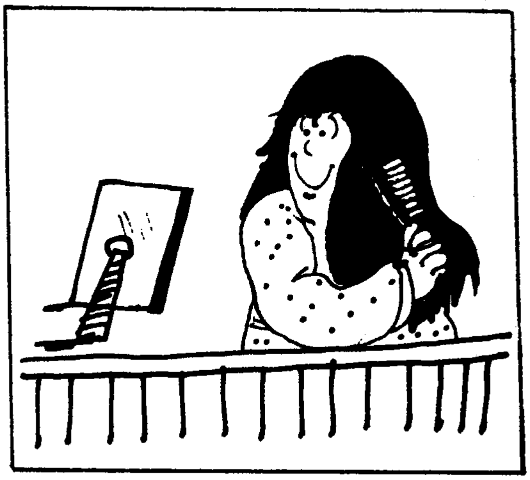
6 electrons

Electrons and protons have a fixed but small amount of electricity or *charge.* Neutrons have no charge. The charge of an electron and that of a proton are equal in strength, but opposite in effect. Electrons are *negatively charged* and protons are *positively charged.* They are shown by minus (-) and plus (+) signs.

As an atom contains an equal number of electrons and protons, it has no charge and is said to be electrically neutral. In general, the total number of electrons and protons in an object is also equal, so that it has no net charge. Somehow if this balance gets upset, then the object shows signs of being charged with electricity.

Two
STATIC ELECTRICITY

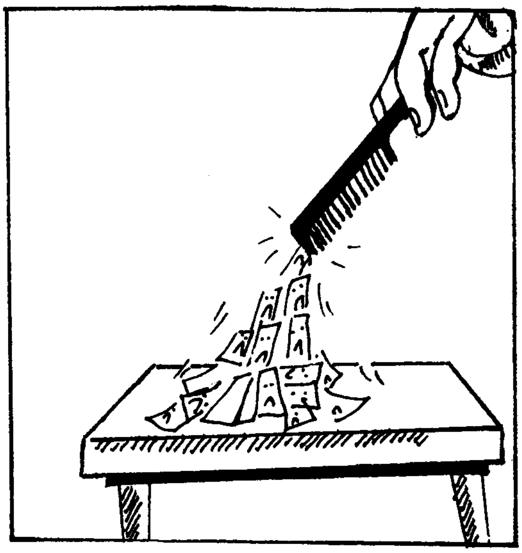
Static electricity can be obtained by rubbing two things together. What kind of things should be rubbed? Let us find out.



You will need:

* a plastic comb
* some pieces of paper

1. Comb your hair briskly.
2. Bring it close to the pieces of paper.
   Why are the bits of paper attracted by the comb?

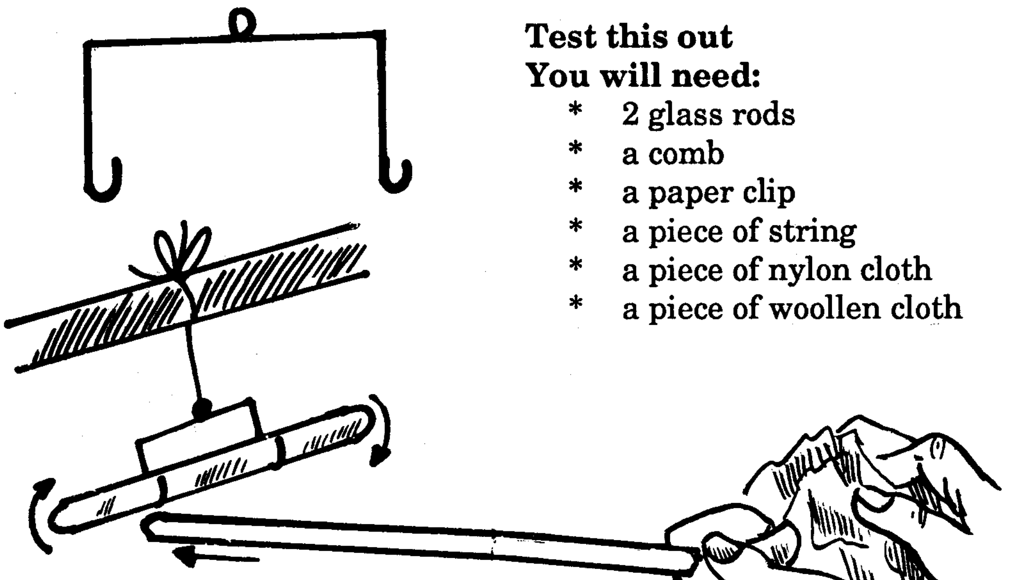


This is what happens:
When you comb your hair, some electrons from the comb pass on to your hair due to rubbing. So the comb now has less electrons than protons and becomes positively charged. The comb is then able to attract the electrons in the atoms of the paper.

So, to display static electricity, we need to rub a material that loses electrons easily with something that can accept these electrons.

How does static electricity work?

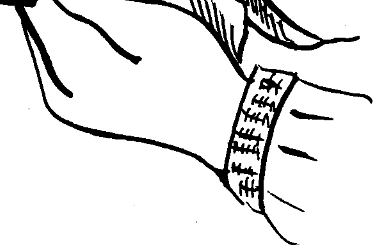
Static electricity works on the basic rule that different types of charges or unlike charges attract, and similar or like charges repel. A positive and a negative charge will attract each other. But two positive or two negative charges will always repel one another.



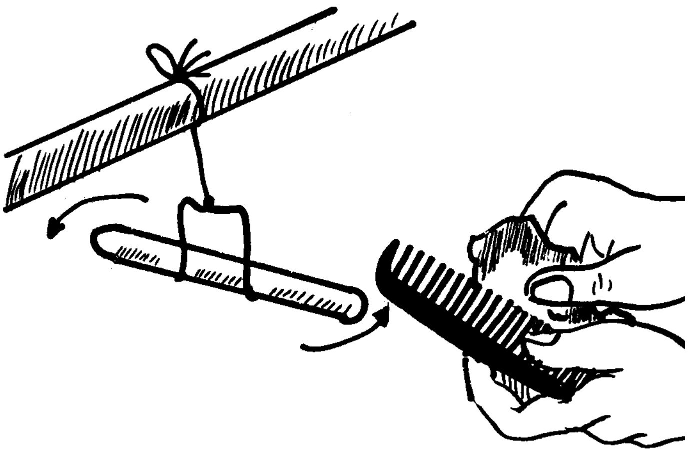
Test this out

You will need:

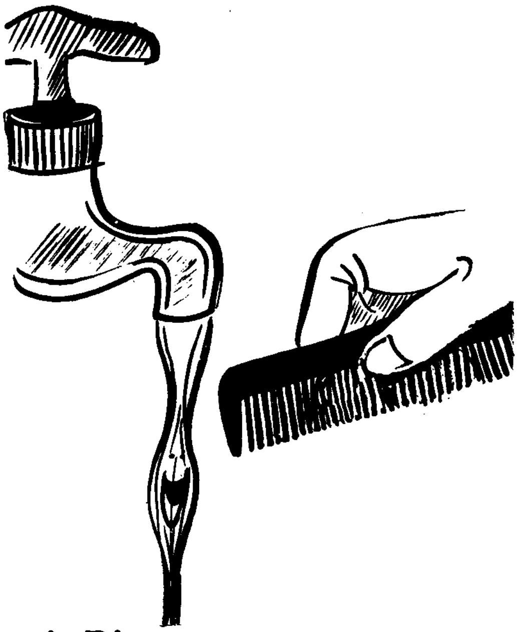
* 2 glass rods
* a comb
* a paper clip
* a piece of string
* a piece of nylon cloth
* a piece of woollen cloth



1. Bend the paper clip to make a hanger. Suspend it with the string.
2. Vigorously rub one of the rods with the nylon. This removes electrons from the rod. It is now charged positively. Place the rod on the hanger.
3. Immediately rub the second glass rod with nylon. Take it near the suspended rod.
   The suspended rod moves away. Why?
4. Rub the comb with the woollen cloth. Bring the comb near the suspended glass rod. This time the rod swings towards the approaching comb. Do you know why?

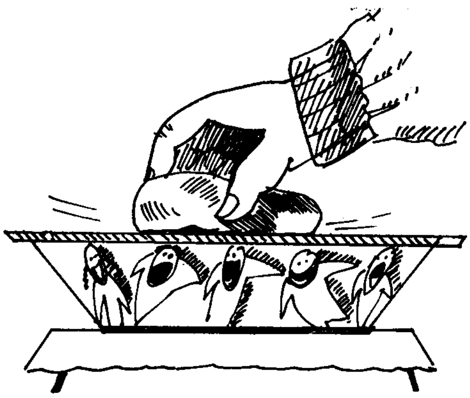


Let's Have Some Static Fun



Electric Water Dance

1. Rub a comb vigorously with a woollen cloth. The electrons from the wool will pass on to the comb making it negatively charged.
2. Take the charged comb close to a thin stream of water. The water will visibly bend towards the comb.

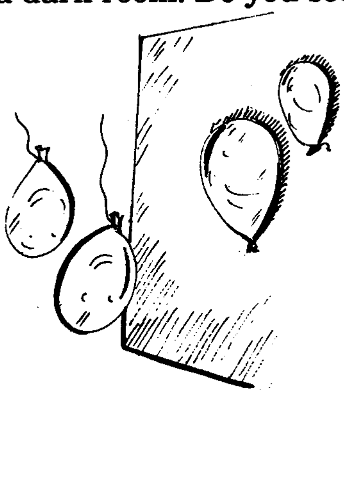


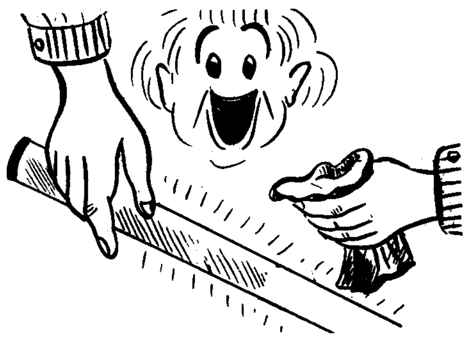
Electric Disco

1. Cut out paper figures of boys and girls from a piece of folded paper.
2. Place them in an aluminium dish about 2.5 cm deep. Cover the dish with a glass plate.
3. Rub the glass vigorously with a piece of silk. Watch the dance.

Let There Be Light

Get a fluorescent light bulb. Rub it briskly with a piece of fur or flannel in a dark room. Do you see light?





Birthday Delight

For your birthday, decorate the walls of your room with balloons. Blow up the balloons. Rub them briskly against a piece of fur. Place them on the wall. They stay there.

How to look for a charge

An *electroscope* is an instrument which can detect very weak charges of static electricity.

Make Yourself an Electroscope

You will need:

* a wide-mouthed glass jar
* a cork to cover the jar
* a piece of copper wire
* 2 pieces of aluminium foil about 1 inch long and $^1/_4$ inch wide
* a plastic comb
* a piece of woollen cloth

1. Push the copper wire through the cork so that a part of the wire juts out on top of the cork. Bend the bottom end of the wire in the shape of an L.
2. Attach the aluminium foil strips over the wire and pin them together. Lower the strips into the jar till the cork fits the mouth of the bottle.
3. Rub the comb with the woollen cloth to charge it. Bring it near the top of the wire.

What do you observe?

The charges from the comb will transfer through the copper wire to the aluminium strips making them repel each other and fly apart. You can remove the charge with a touch of your finger. When you touch the aluminium strips, you actually connect them to the earth with a path through which the electrical charge passes.

Did you know that electrical appliances have a grounding or earthing wire inside to protect users from electrical shocks?

Atmospheric Charge

Dry air has a lot of static electricity. Clouds also often have very large amounts of charge stored in them. When two such clouds come near each other, the energy stored in their charge can make the air atoms between the clouds emit light. This spark of light is called lightning. Lightning can also pass from a cloud to the ground. That is dangerous.

So tall buildings have lightning conductors. A lightning conductor is a metal rod attached to the highest point of a building and connected to the earth. This leads the charge safely to the ground when struck by a lightning.

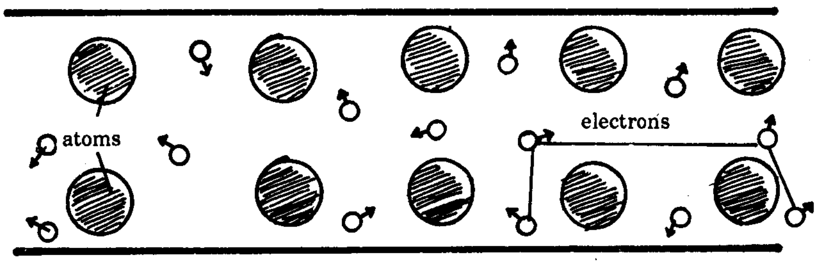
Did you know that a lightning bolt can reach temperatures of up to five times hotter than the sun's surface? The air around a lightning bolt heats up and expands very suddenly, creating a loud sound called thunder.

Take Care

Do not stand near trees. Lightning strikes tall objects and high buildings. If you are in a car, stay inside. Do not touch the metal parts of the car. Stay away from wire fences. Stay away from water. It also attracts lightning.

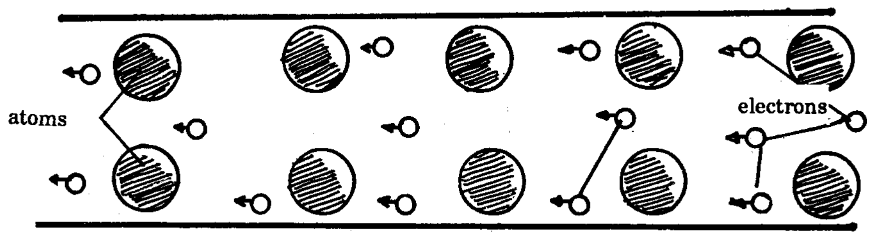
Three
ELECTRIC CURRENT

To light a bulb, all you need to do is press a switch. When the switch is on, an electric current flows through the wire. What is this current made of?
Wires have a very large number of loose electrons that move about within it in a random way. A battery or the mains supply at home pushes these free electrons, so that they all move in one direction. *An electric current consists of a flow of these electrons.*



A metal wire with randomly moving electrons.

A wire through which current is flowing.



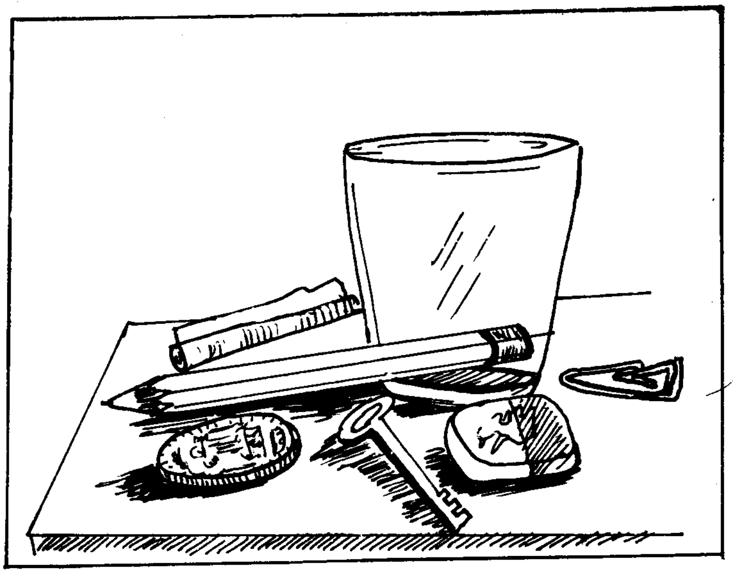
Did you know?

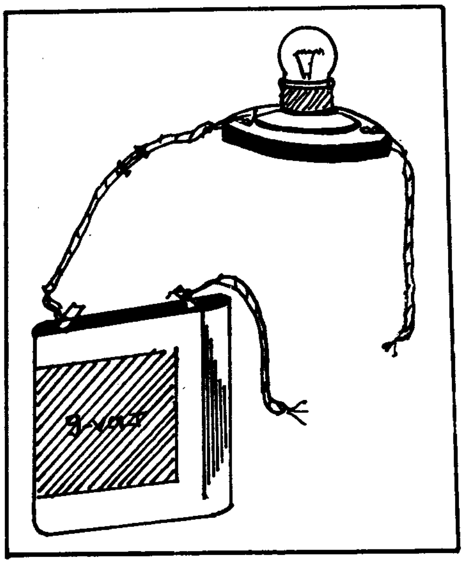
* There are two types of current. (DC) or direct current is produced by batteries and flows in one direction. They are used in automobiles and flashlights.
* (AC) or alternating current continually reverses the direction of its flow. The current supplied to homes and schools through the mains supply is alternating current.

Can current flow through everything? To test, first make this simple connection.

You will need:

* a small torch bulb and socket
* a 9-volt battery
* two battery clips
* 3, 10-inch long insulated wires
* things to be tested: aluminium foil, pencil, glass, paper clip, plastic, coin, key, eraser

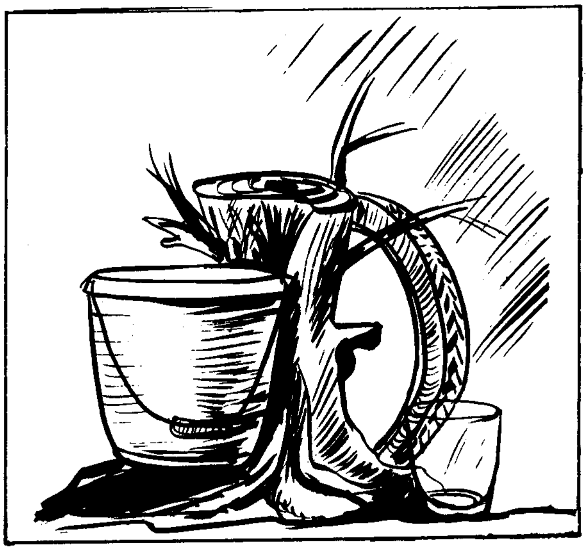




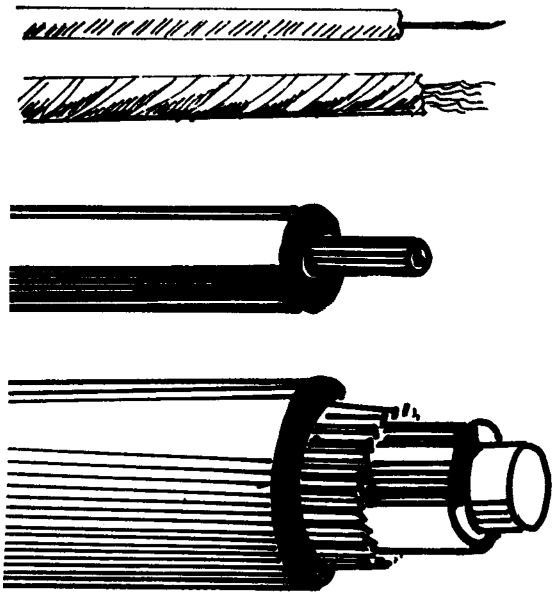
1. Remove 1 inch of plastic from the ends of the wires.
2. Connect two wires to the two terminals of the battery.
3. Connect one of these wires to an end of the bulb and socket as shown.
4. Attach the third wire to the other end of the bulb.
5. Place the objects under test on the table and touch them one by one with the free ends of the wires. Be sure to touch only the insulated part of the wires with your hand. What happens each time?
6. Note down your result.

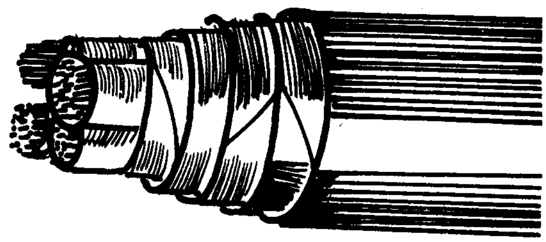
You must have found that some materials made the light bulb glow. These materials, like the aluminium foil, paper clip, coin and the key allow current to pass through them. They are **conductors** of electricity. Most metals are good conductors.

Other materials like wood, glass, plastic and rubber are examples of bad conductors of electricity. They are called **insulators.**



Insulators are as useful as conductors in making a current flow from one place to another. *Can you say why?*
We use conductors to carry electricity where it is needed and we use insulators to prevent it from leaking into places where we do not want it. Wires used in electrical connections are covered with plastic to make them safe to handle. This is called insulation.





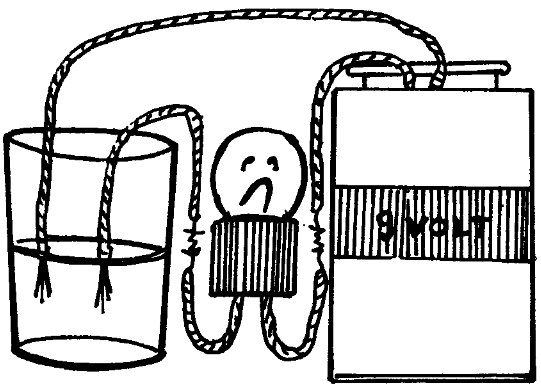
Look for insulation in wires
Collect different types of wires. Cut them to check the insulation. Thick wires have rubber covers wrapped with thread as insulation.

Pure water is a poor conductor of electricity. Pure water is free of impurities. Tap water which is not filtered is a good conductor of electricity. Dry air is also a poor conductor of electricity. But wet air is not.

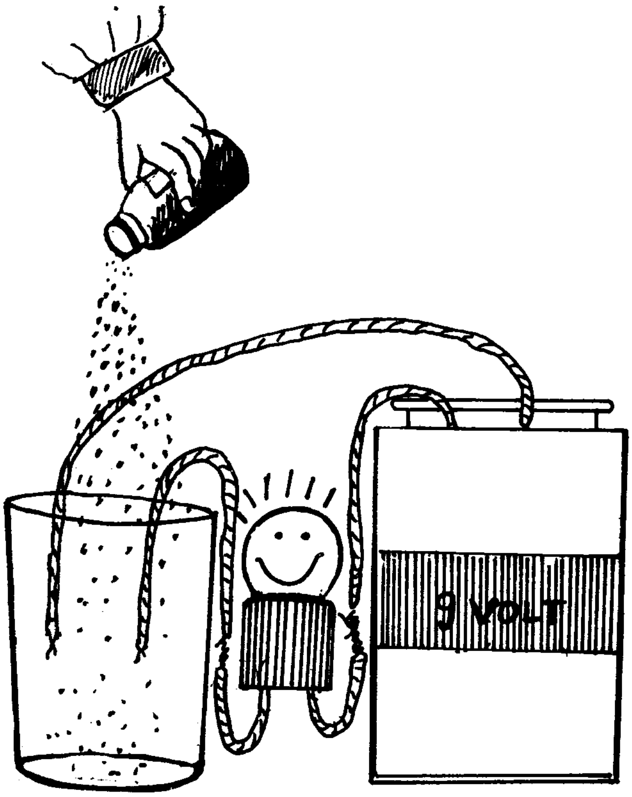
Change pure water into a better conductor of electricity like this:

You will need:

* a light bulb and socket
* 3 one-foot lengths of insulated wire
* a 9-volt battery
* a drinking glass
* distilled water
* $^1/_2$ cup salt



1. Remove one inch of insulation from both ends of each wire.
2. Connect the light bulb and socket, the wires and the battery, as shown.
3. Fill pure, distilled water into the glass.
4. Place the bare wires in the glass of water. Make sure your hands do not touch the water or the wire. Does the bulb light up?
5. Add salt to the glass of water. Does the bulb light up now?



Take Care

Did you know that you are a very good conductor of electricity?

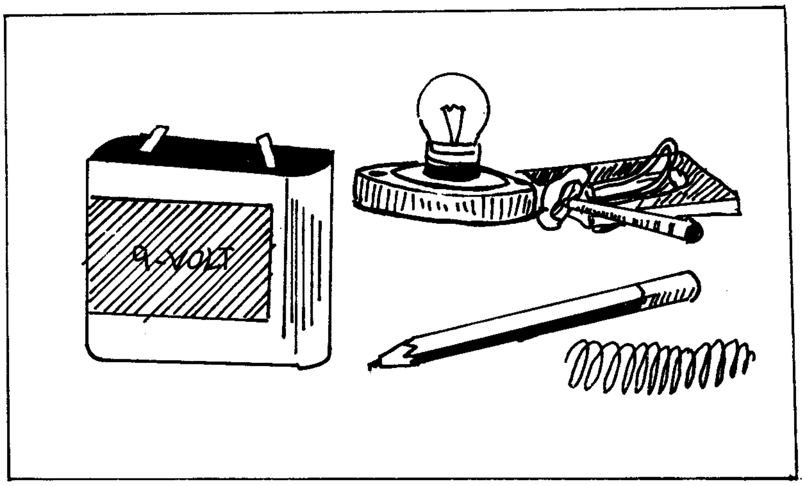
* Remember to handle all electrical appliances with care when near water.
* Never touch switches and wires with wet hands.
* Always wear rubber slippers when working with electrical circuits. This will insulate your body.

The *resistance* offered by any material to the flow of current can be measured in terms of **ohms.** Conductors have very low resistance while insulators have very high resistance.

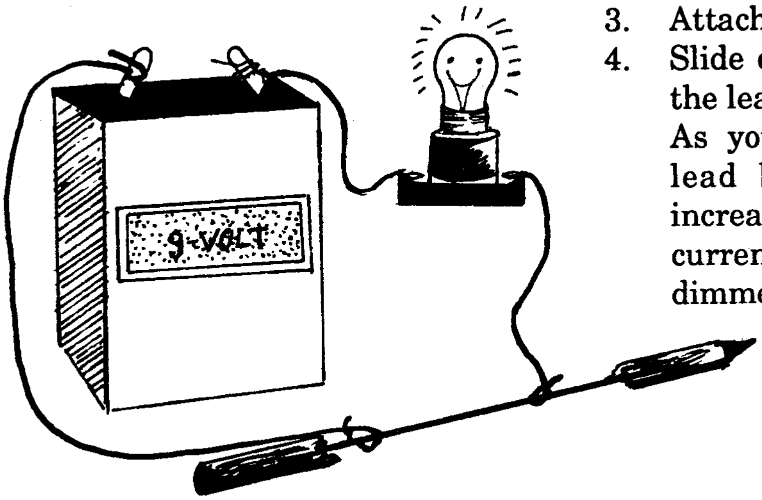
Make a Variable Resistance: A variable resistance is called a *rheostat.*

You will need:

* a pencil
* a hammer
* a 9-volt battery
* 2 battery clips
* a torch bulb with socket
* 3 insulated wires



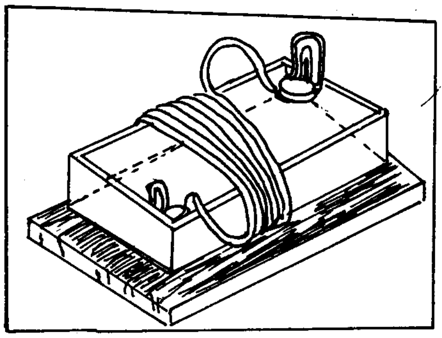
1. Tap the pencil gently with a hammer so that the lead is exposed. Take care not to break the lead.
2. Cut out an inch of insulation from each end of the wires.
3. Attach the wires as shown.
4. Slide one end of the wire along the lead. What do you find?
As you increase the length of lead between the wires you increase the resistance. So less current flows, and the bulb gets dimmer amd dimmer.



Guess what will happen if, instead of lead, you had used a copper wire or a glass rod.

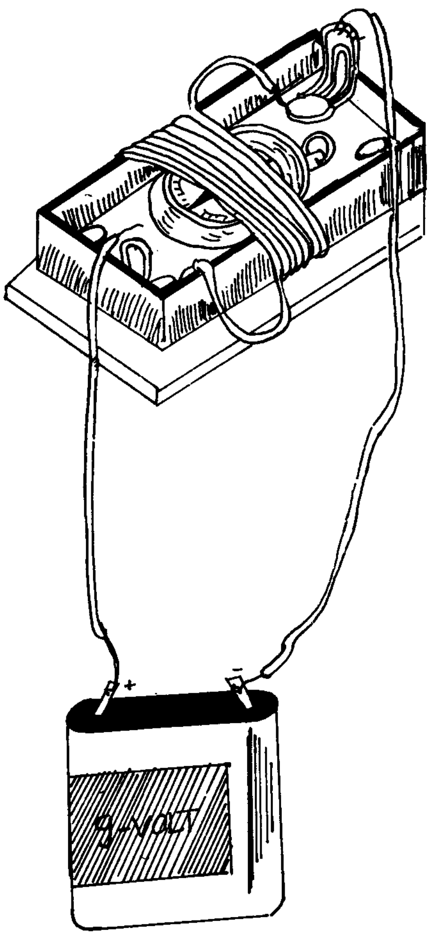
Can you measure electric current?

A *galvanometer* is a current-measuring instrument. It detects the presence of an electric current.



You will need:

* a magnetic compass
* a 9-volt battery
* a block of wood 4" x 5" x 1"
* the cover of a small cardboard box
* 4 board pins
* 2 paper clips
* some insulated wire



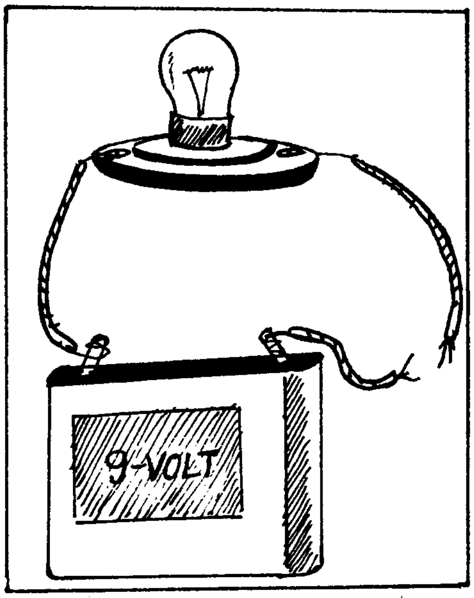
1. Wrap about 10 turns of the insulated wire around the cardboard.
2. Scrape the insulation from the wire ends.
3. Place the cardboard on the block of wood and secure it in place with board pins. Do not push the pins completely down.
4. Wrap the ends of the wires around two board pins.
5. Bend the paper clips in half. Slip the clips under the pins and push the pins firmly down.
6. Place the magnetic compass inside the lid of the box.
7. Connect two wires to the two terminals of the battery. Fix one of these wires to one clip.
8. Touch the other paper clip with the second wire. What do you observe? The compass needle moves, showing that there is a magnetic field around. A flow of current through the wires created this magnetic field.

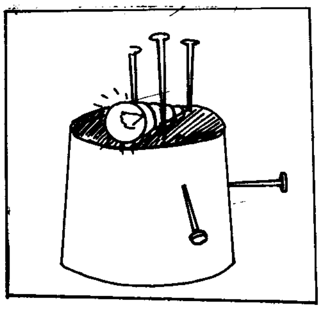
If a scale could be attached to the compass, you could actually measure current. An **ampere** is a measure of the strength of current.

Four
CIRCUITS

To operate any electrical gadget, current has to flow from the mains supply or a battery to the gadget, and back to the supply. The path taken by a current is called a circuit.

A circuit is like a race track. It begins and ends in the same place. If the path is broken, current will not flow.





Make a Simple Circuit
You will need:

* a torch bulb with socket
* a 9-volt battery
* 2 battery clips
* 3 pieces of insulated wire

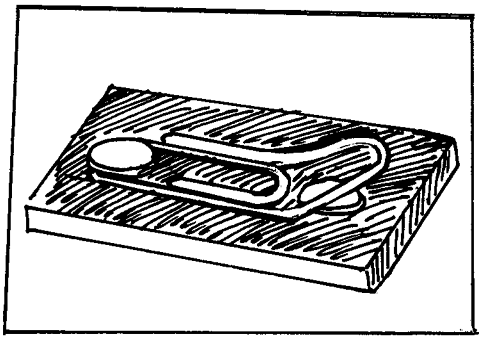
1. Remove the insulation from the ends of each wire.
2. Connect the wires to the battery and the bulbs as shown. In case you cannot find a socket, drive three nails into the top of a cork to support the bulb. Drive two more nails into the side of the cork. They should touch two of the vertical nails. This helps to make the electric connection.
3. Touch the two free ends of the wires. What do you find? Current flows when the circuit is complete and the bulb glows.

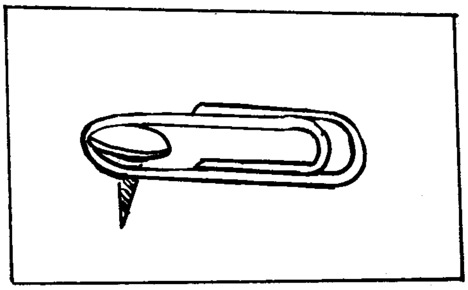
In order to operate the bulb only when you want, a switch can be connected between the two free ends of the wires in the circuit you just made. A switch is a simple device that can connect or break a circuit.

Make a Switch

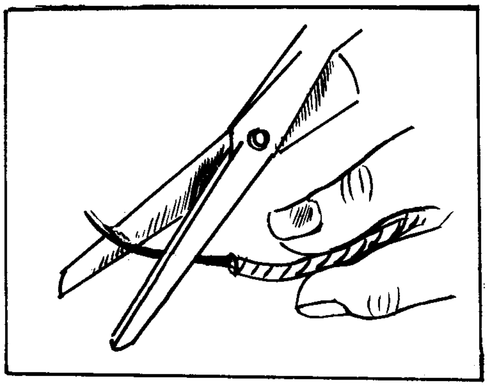
You will need:

* 2 one-foot lengths of insulated wire
* 2 board pins
* a paper clip
* a thick $^1/_2$" x 2" cardboard or a wooden board

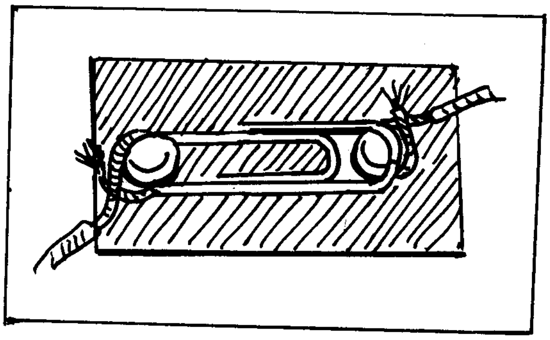




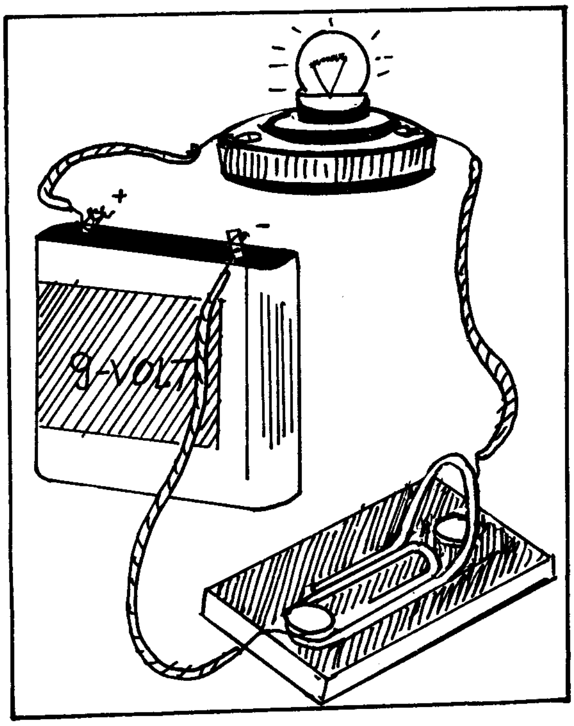
1. Place a board pin through one end of the paper clip.
2. Push the pin through the cardboard. Fix the other pin, so that they are about $1^1/_2$" apart. Bend the end of the clip upwards. The clip should touch the pin head when you press it down with your finger.



3. Remove 1" of insulation from the ends of each wire.
4. Twist one end of each wire tightly around the pin heads.
5. Press the pins firmly against the board and the switch is ready. You can use this simple switch in your circuits.



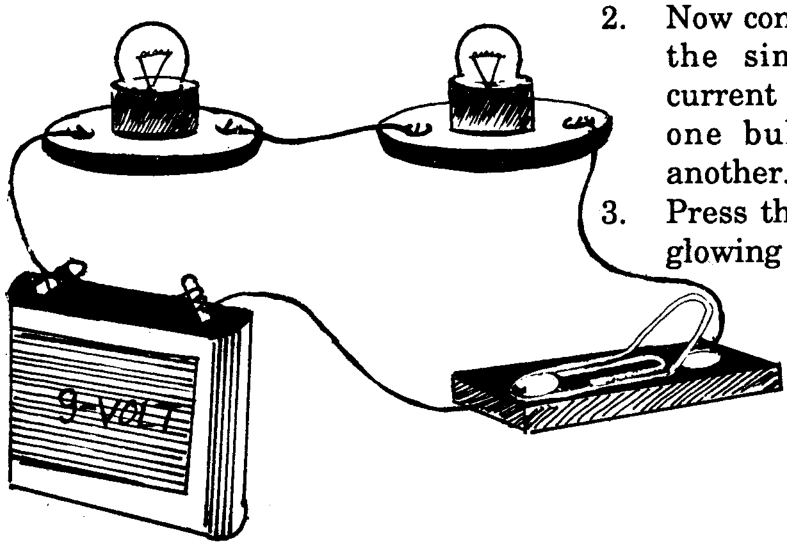
The best way to learn about circuits is to make some simple circuit with batteries. Let us do that.



You will need:

* two 9-volt batteries
* 4 battery clips
* 2 torch bulbs with sockets
* a home-made switch (instructions on page 19)
* insulated wire

1. Connect a battery, a bulb and the switch as shown.



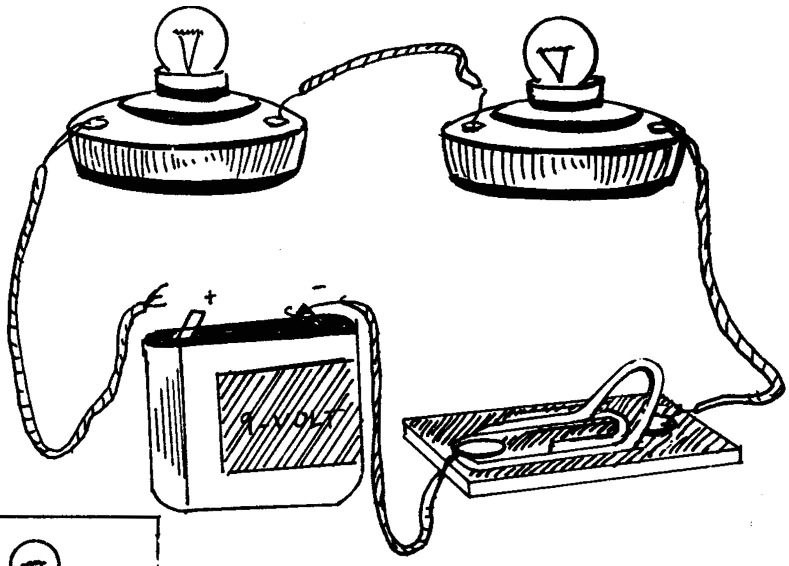
2. Now connect the other bulb into the simple circuit, so that current will flow first through one bulb and then through another.
3. Press the switch. Are the bulbs glowing as brightly as before?

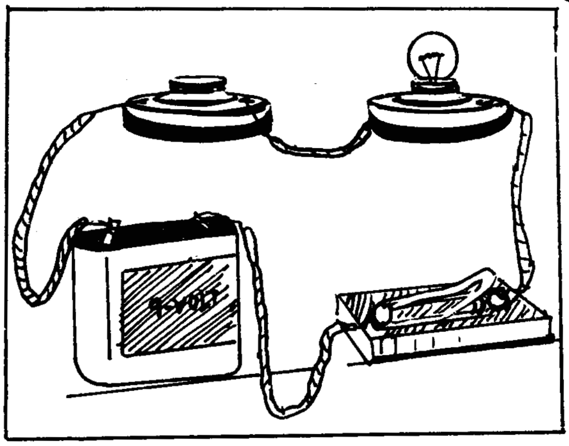
A circuit connection like this is called a *series connection.* The bulbs are not so bright because now two bulbs are sharing the 9 volts between them.

The *push* that forces a current through a circuit is measured in **volts.** The push applied by the battery to the electrons in the wire, in this case, is 9 volts.

4. Disconnect one wire. Press the switch. What happens?

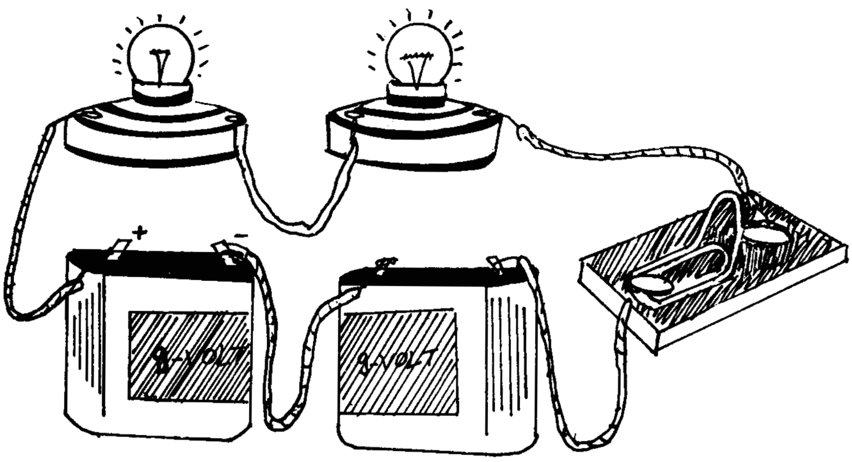
5. Connect the wire in place. Take out a bulb from a socket and press in the switch. What do you observe?



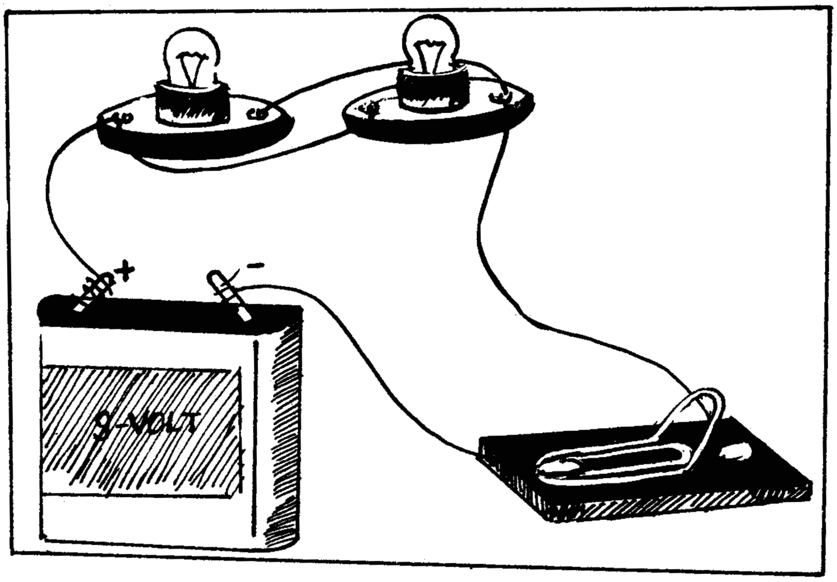


In a series circuit, electricity is stopped from reaching any part of the circuit if just one path is broken. This is why both lights went out when you disconnected just one wire, or took out one bulb from the circuit.

6. Voltage in a series circuit can be increased or decreased. Connect the other 9-volt battery to the first one, so that the positive terminal of the first is connected to the negative terminal of the second. The voltage becomes doubled. As a result, the bulbs glow brighter than before.

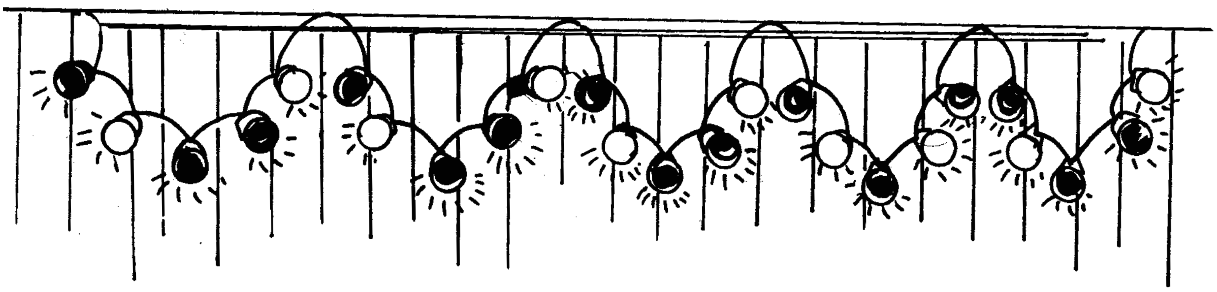


7. Now disconnect the second battery and connect the bulbs as shown.
8. Press the switch. Notice that both the bulbs glow brightly this time. This is a *parallel circuit.* In this connection both the bulbs are directly connected to the battery terminals and so both are receiving the full 9 volts.



Rules of Series and Parallel Battery Connection
Two batteries in series, double the voltage. Two batteries in parallel, double the current.

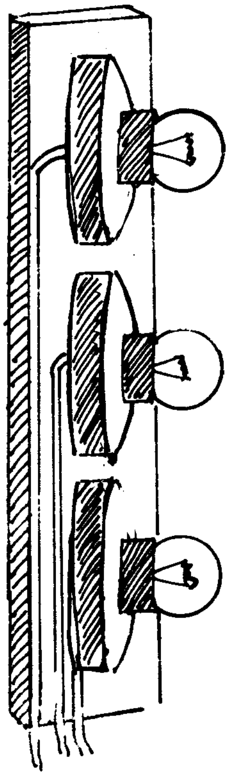
Light up your home
What do you think will happen to this lighting arrangement if one bulb fails?

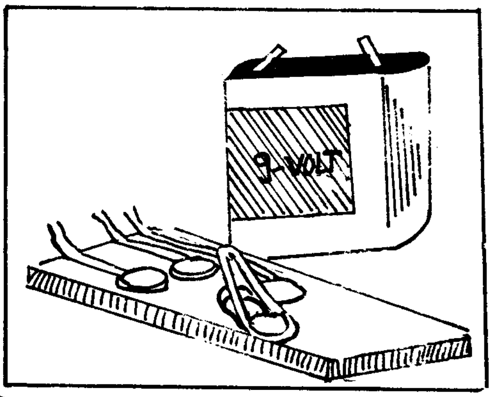


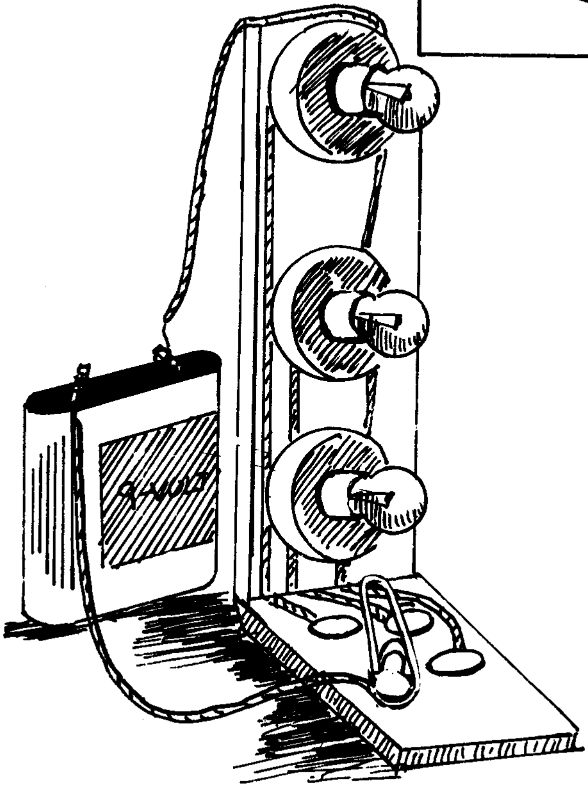
Think it over
Are the electrical wires in houses connected in a series or in a parallel circuit? What about street light connections?

Make a Model Traffic Signal
You will need:

* 3 torch bulbs and sockets
* a 9-volt battery
* 2 battery clips
* an L-shaped wooden board
* 4 board pins
* a paper clip
* same insulated wire
* red, green and orange colour paints



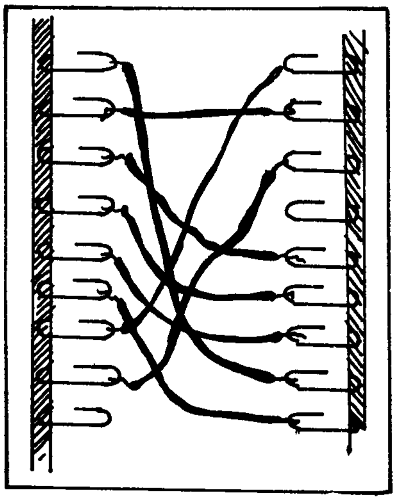


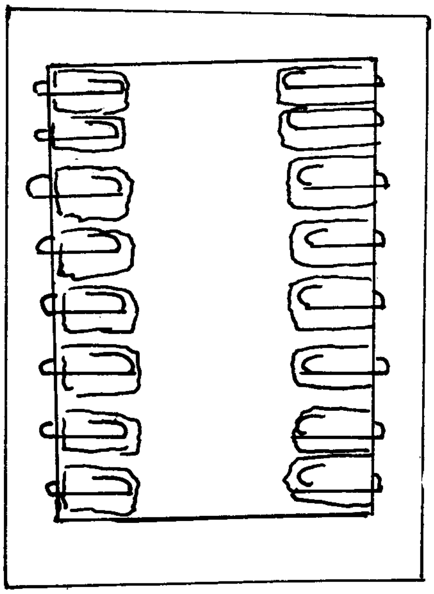


1. Make a 3-way switch with the 4 board pins and the paper clip, as shown, at the base of the wooden board.
2. Fix the torch bulbs as shown. Paint them red, orange and green so that they look like traffic lights.
3. Wire them to the battery through the 3-way switch. The bulbs are connected in parallel. So they can be switched on separately.
4. Connect the switch alternately to the three board pins to operate the traffic signal.

Make an Electric Quiz Game
You will need:

* a small light bulb with socket
* a 9-volt battery
* 2 battery clips
* $8^1/_2$" x 11" piece of thick cardboard
* ten 1" lengths of insulated wire
* 20 paper clips
* 20 slips of paper, $^1/_2$" x 2"





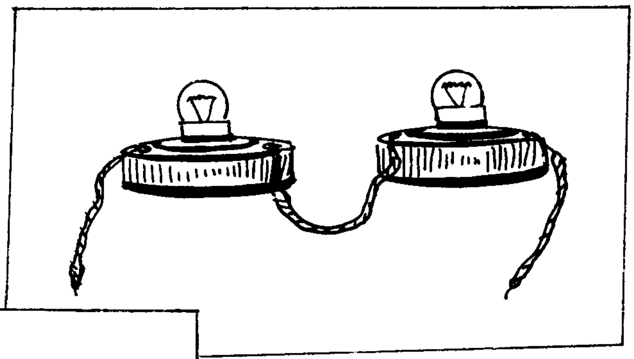
1. Connect the battery to the bulb and socket.
2. Assemble the wires and the clips as shown.
3. Write questions on ten slips of paper and the answers on the remaining ten slips. Place a question under each clip on the left edge of the board and its answer under the connecting paper clip on the right.
4. Touch one battery wire to a question clip and the other battery wire to a correct answer clip. The bulb will light up.

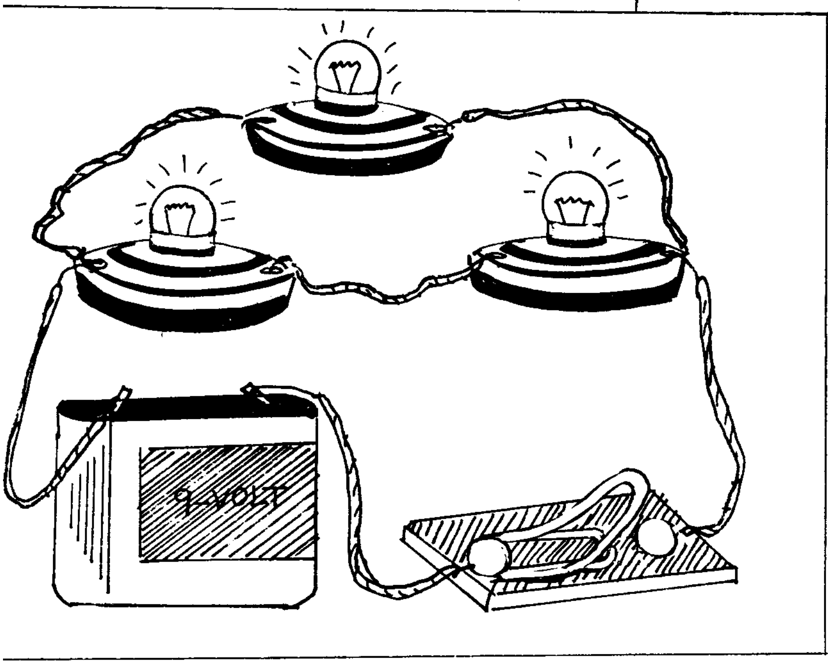
Your electric quiz game is ready. Try it out on friends.

Electric current, like water, air, heat, sound, you and me, chooses the easiest path—the path of least resistance. Let us check.

You will need:

* 3 torch bulbs with sockets
* a 9-volt battery
* 2 battery clips
* some insulated wire
* a switch
* a screwdriver





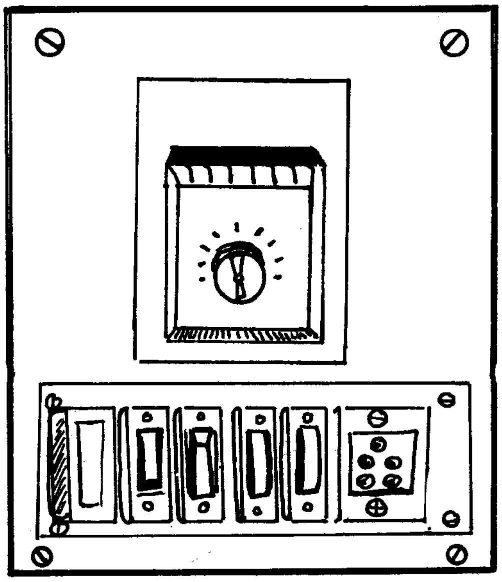
1. Connect bulbs in series, like this.
2. Make the circuit as shown, with the bulbs, in series and the third bulb, connected to the battery in parallel.
3. Press the switch. Which of the bulbs glows brightest?
You must have found that the single bulb glows brighter than the two in series. This is because more current passed through the single bulb (less resistance) than the double bulb (more resistance). In other words, the current preferred the path of lower resistance.
4. Now put the screwdriver across the battery. The metal part should touch the wires.
5. What do you find when you press the switch? The bulbs go out, because the metal screwdriver has very low resistance. This is called a **short circuit.**

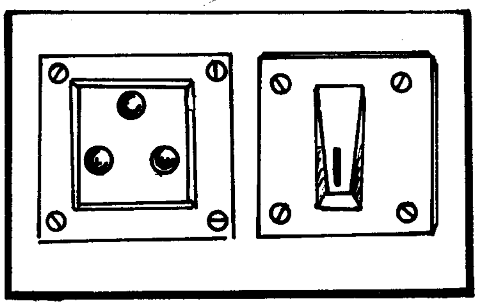
A short circuit can occur when two wires in a circuit accidentally touch each other. This may even cause a fire—be careful.

Five
ELECTRICAL HOUSE RULES

Although you have been experimenting with electricity, and perhaps feeling more at ease while dealing with it, always remember that electricity is dangerous. Many electric fires kill people. Many people die from electrocution as well. It is best to be cautious. But you need not panic. Electricity is of great help, if you know the rules of the game. The three electrical house rules are:

1. know about the basic electrical components used at home,
2. have a periodical electrical-safety check-up, and,
3. be an electricity conservationist.



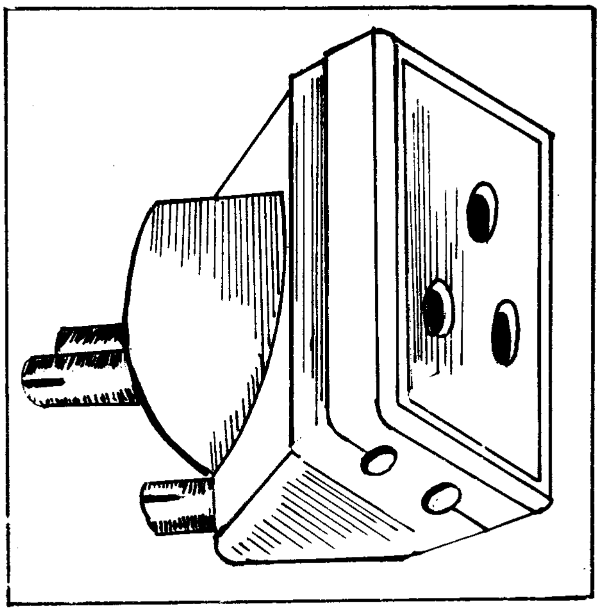


Let us take a look at some of the electrical components you see everyday.

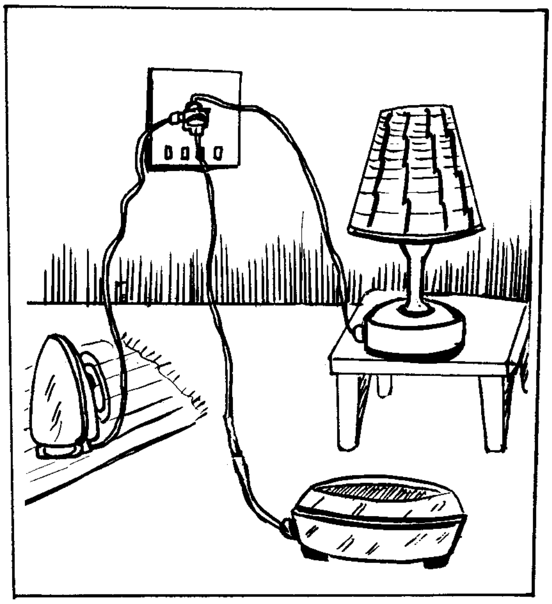
Our home supply is 220 volts A.C. mains. It is fed to the switchboards through complex wiring.

Take a look at the switchboards in your house. Apart from on-off switches and a fan regulator, you will find two kinds of outlet points, called sockets, or plug points. One is the small two- or three-pin point and the other is a large three-pin socket. The smaller point can supply a maximum current of 5 amperes. The bigger one is called a power point. It can provide a maximum of 15 amperes of current. Refrigerators, heaters, coolers etc. should always be connected to power points. The small plug points are meant for lighting bulbs and running other low-power gadgets like radios and tape recorders.

A multi-point plug has two or three plug points. Different electrical appliances can be run from a multi-point plug. Suppose you want to use a hotplate, a bulb and an electric iron from the same plug point. Can you do so? Let's find out.



All electrical appliances are rated in **watts**. A watt is a measure of the amount of electricity an appliance uses. A watt is equal to the voltage times the current used, i.e.,
1 watt = 1 volt x 1 ampere.



Suppose you connect

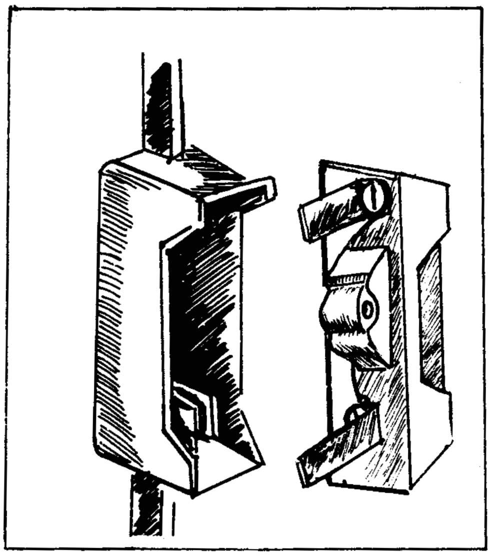
a hot plate of	1000 watts,
a bulb of	100 watts, and
an iron of	750 watts to a plug.
	1850

So the total wattage adds up to 1850 watts.

You know that the mains supply is 220 vclts. As 1 ampere = 1 watt/1 volt, the current used by the hotplate + bulb + iron = 1850 / 220 = 8.4 amperes.

Just imagine, the hotplate, the bulb and the iron will forcefully draw their required 8.4 amperes of current from your plug point which can safely supply only 5 amperes. In other words, you have put more load, or *overloaded* your line. Never do that. This is dangerous. It can blow up the whole electrical connection of your house!

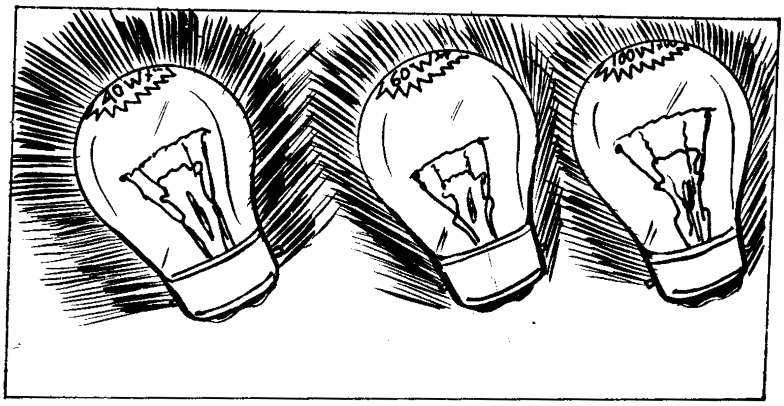
In order to avoid this danger, *a fuse box* is attached to the house wiring. A fuse box has a number of *fuses*, connected to different circuits. A fuse is a piece of thin wire which melts and breaks the circuit if the current is greater than what it should be.



With the help of an adult, open a fuse box and take a look inside. Take out a fuse and look at the connection. You can replace a fuse wire easily.

Many electrical appliances have their own fuses attached to them.

Modern houses have electronic circuit breakers instead of fuses. Have you seen a circuit breaker?



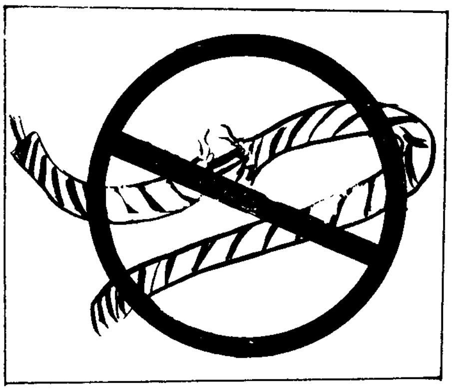
Check the wattage of things around:

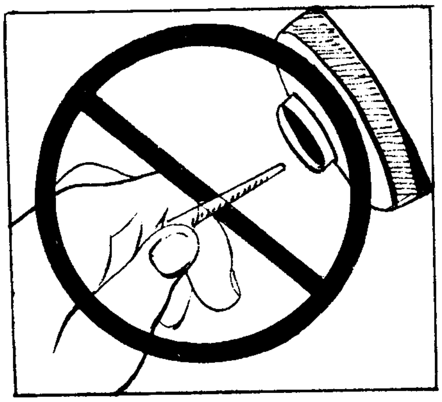
1. Take three bulbs of different strengths (40 watts, 60 watts, 100 watts). Check what is written on them. With the help of an adult, connect them to a tablelamp socket. Which one glows the brightest? Why?
2. Check the wattage rating of a heater, an electric iron, a fan and a refrigerator. You will notice that all electrical appliances have a label to specify the wattage and the voltage to which it should be connected.

(Note that some labels have 240 volts or 250 volts written on them instead of 220v.)

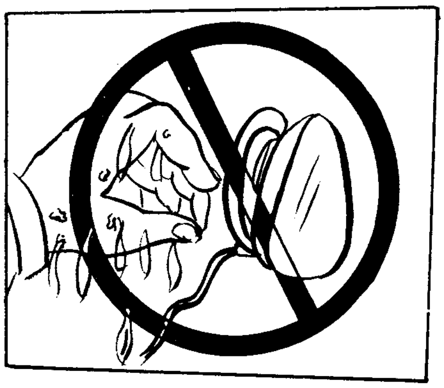
Do a periodical electrical safety check-up

* Look for frayed cords on electrical appliances and fixtures, especially near plugs.
* **Never** touch bare wires exposed by a damaged cord while the cord is plugged.
  Cover all unused electrical outlets with plugs or insulated tape.





* **Never** leave light sockets open. Remove bulbs that are fused only when you have a new one to replace.
* **Never** insert a screw driver into a plug point. Electricians use a *tester* to test whether a plug point is working or not.
* **Never** connect high wattage appliances to a two-pin plug point. A two-pin point has no earthing wire to earth the appliance. You may receive a shock when you touch it.
* **Never** touch switches and electrical appliances with *wet hands.* Water is a good conductor of electricity and so are you.
* **Never** leave a television set or a computer monitor on when out of the house.



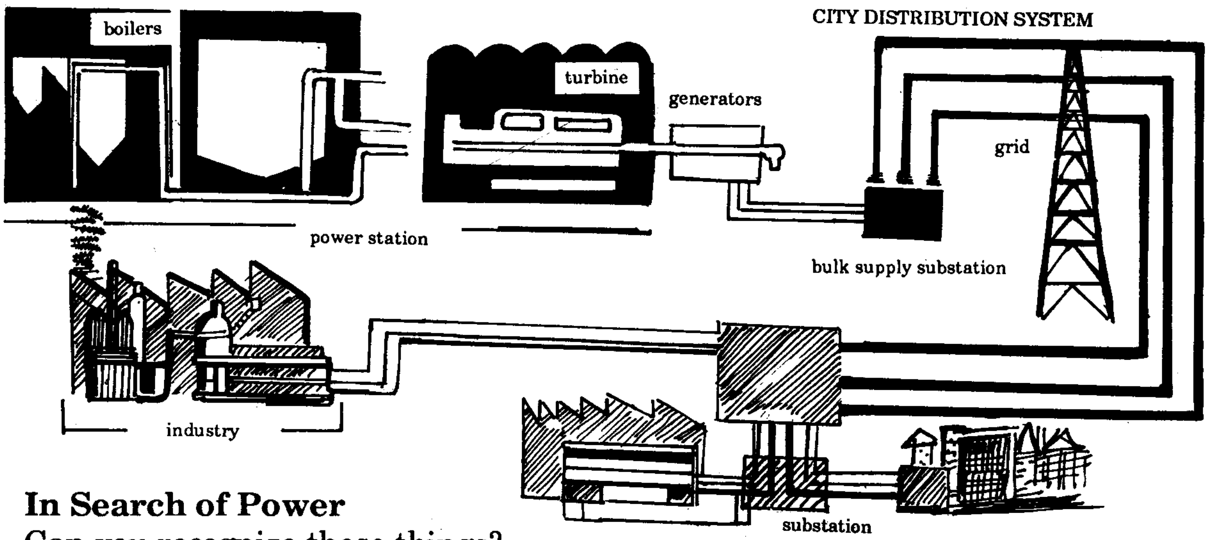
Be an electricity conserver

Electricity is expensive. Use it carefully. Remember the discomfort during power cuts. That should make you consume less.

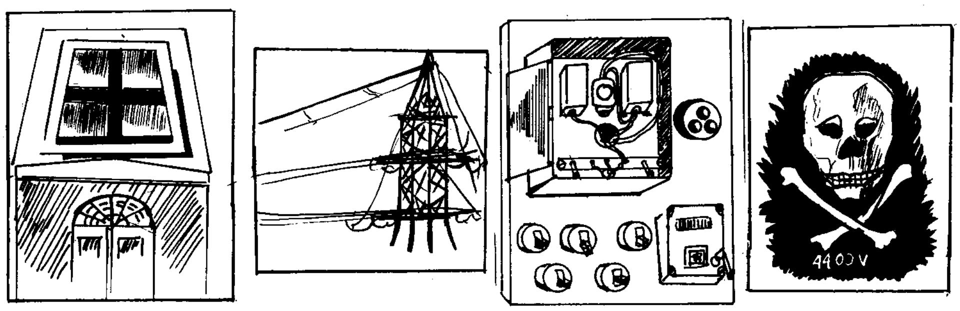
* Turn off light, fans and the TV when they are not needed.
* Use air conditioners and heaters sparingly.
* Don't waste hot water.
* Open the refrigerator door as seldom as possible.

Six
POWERFUL SOURCES

Most of the electricity we use is from the *mains supply*. The mains supply is generated in Power Stations, often away from the city, and transmitted by wires to homes, offices and factories. There is a network of these wires running throughout the country. These wires carry a very high voltage to sub-stations where the voltage is reduced. This reduced voltage is distributed to users through underground cables and overhead wires.



In Search of Power
Can you recognize these things?



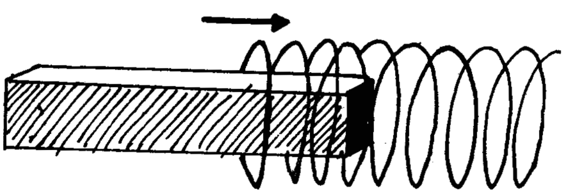
Ans: solar cells, transmission lines, meter box, high voltage danger sign.

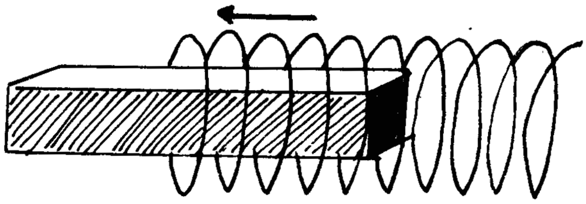
Electricity from Magnets

Power stations produce electricity by the effect of a magnet on a rotating machine. These are called generators.

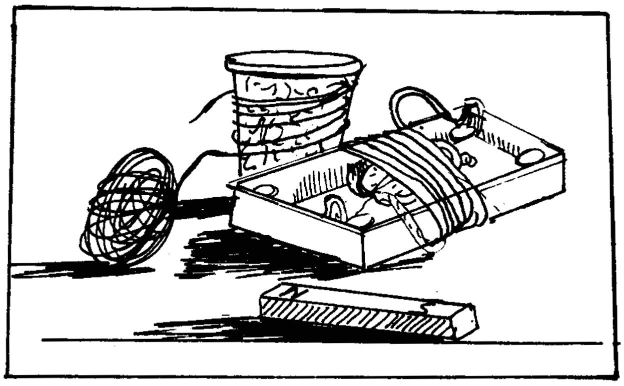
How does a generator work?

If a magnet is continually pushed in and out of a coil of wire, an electric current is produced in the wire. The same thing happens if the wire is moved instead of the magnet.



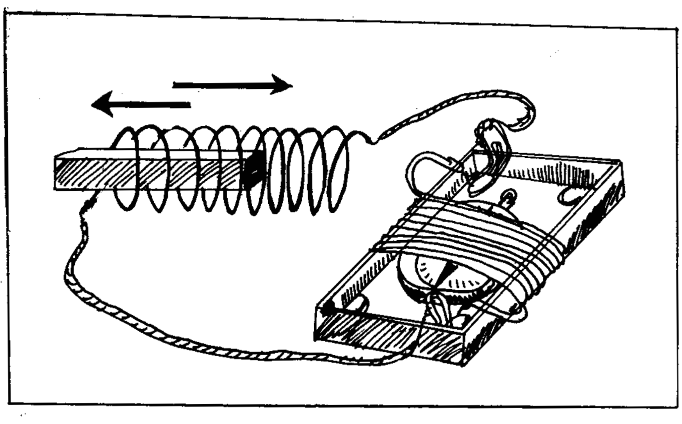


Make Your Own Generator



You will need:

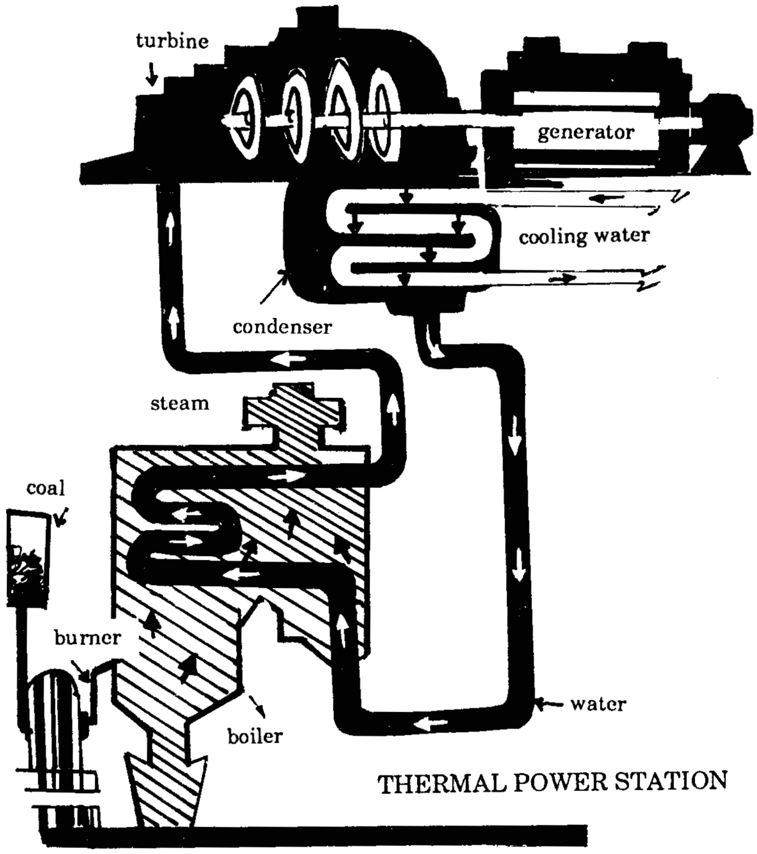
* 6 feet of insulated wire
* a paper cup
* a home-made galvanometer
* a bar magnet



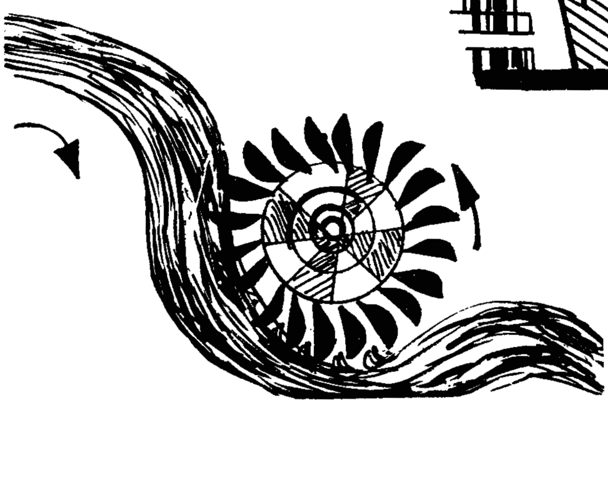
1. Wind 40 turns of wire around the paper cup, beginning 1 foot from the end of the wire.
2. Collapse the cup. Take out the loop and tie it with strings to secure it.
3. Connect the ends of the wire to the galvanometer.
4. Move the magnet in and out of the coil as shown and notice the movement of the galvanometer needle.

A generator makes electricity. A turbine turns a generator. What turns the turbine? Some kind of energy is necessary to turn the turbine. In thermal power stations the heat energy from coal or oil is used to produce steam. The steam turns the turbine and generates electricity.

The heat from nuclear fuel can also do the same job. This is done in nuclear power stations.



THERMAL POWER STATION



Hydroelectric power stations use the energy of falling water to turn a turbine.
For small generation units, biogas, wind, and tides of seas are also used to rotate the turbine.

Make a Small Water Turbine

You will need:

* a cork
* a knitting needle
* 6 pen nibs
* a wire hanger
* a plastic bottle
* a nail
* water

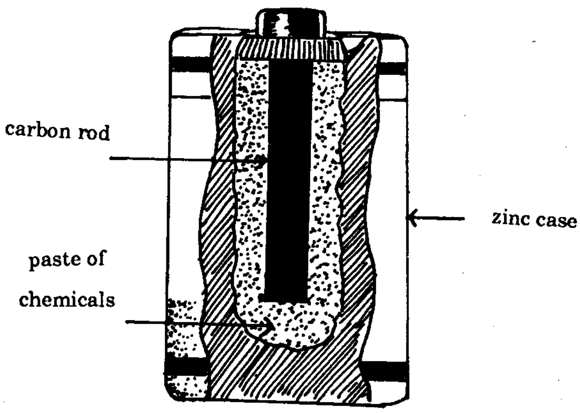
1. Push the knitting needle through the cork, as shown.
2. Stick the nibs into the cork, so that they stick out at right angles. The nibs should be evenly spaced. This is your rotor.
3. Bend the hanger to form a cradle for the rotor. Place the rotor on the hanger, and the turbine is ready for action.
4. You can make the turbine spin by placing it under the tap. But it can be done more effectively by using a water jet from a plastic bottle. Pierce a hole near the bottom of the bottle with a nail. Fill the bottle with water. Arrange your turbine so that the water jet strikes the nibs at right angles. Place the bottle under a slowly running tap, so that the water level in the bottle is maintained. Otherwise the jet will not reach the rotor blades (i.e., the nibs).

Electricity from Chemicals

Batteries use chemical energy to produce electricity. A reaction between chemicals inside a battery produces a voltage across its terminals.
Let us take a look inside a torch battery. Torch batteries are called dry cells.

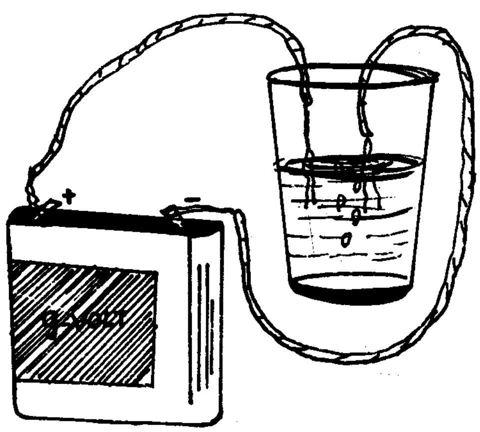
1. Remove the outer covering from the cell.
2. With a knife, cut the battery in half and take a look. You will find a metal zinc case with a carbon rod in the centre.
3. Is there a brass cap attached to the carbon rod? This is the positive terminal of the battery. The bottom of the zinc case forms the negative terminal.
4. What is there between the zinc case and the carbon rod? This is the chemical that acts to produce a voltage between the two terminals of the battery.
5. Notice how the zinc has been eaten away. When the chemicals get used up, the battery weakens and needs to be replaced.

INSIDE A TORCH BATTERY



You know that a battery always has two terminals, one positive (+) and the other negative (-). When connected to a complete circuit, a battery produces an electric current. The current flows from the positive to the negative terminals.

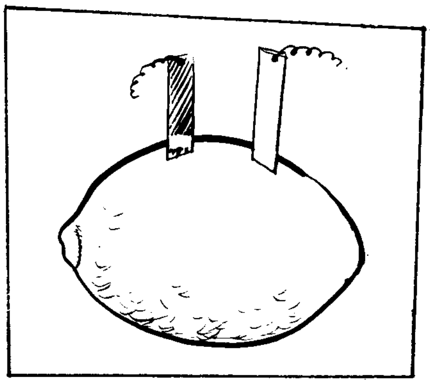
Can you find the terminals of a battery?



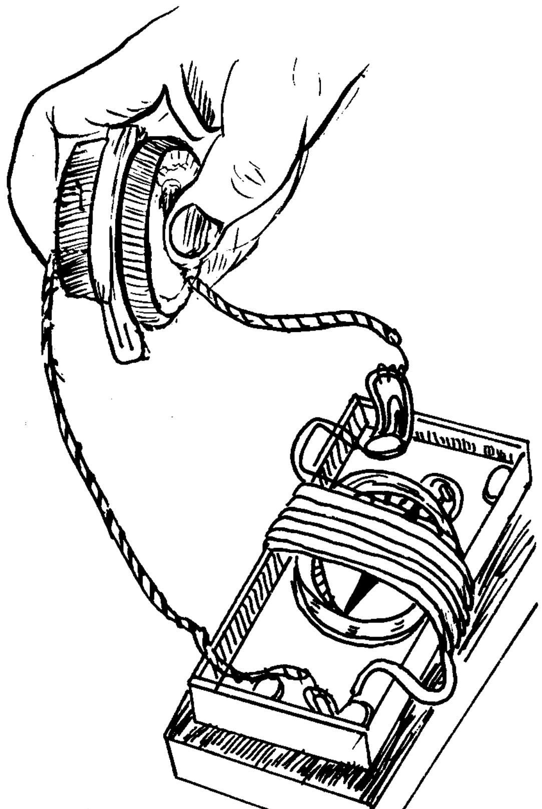
1. Fill a glass $^{3}/_{4}$ with water. Add two tablespoons of vinegar to the water.
2. Connect two wires to a battery and dip them into the water. The wires should be close together but not touching. What do you notice? The wire that is connected to the negative terminal gives out bubbles.

Electricity from a Lemon

1. Have ready the galvanometer you made.
2. Connect one wire from it to a piece of zinc, cut from an old battery cover.
3. Connect another wire to a piece of copper.
4. Roll a lemon on a table to soften it. Push the two metal strips through the skin of the lemon. Make sure they do not touch.
5. Observe the compass needle.
6. Increase the distance between the metal plates. Does this change the meter reading?



Try the same thing with a potato.



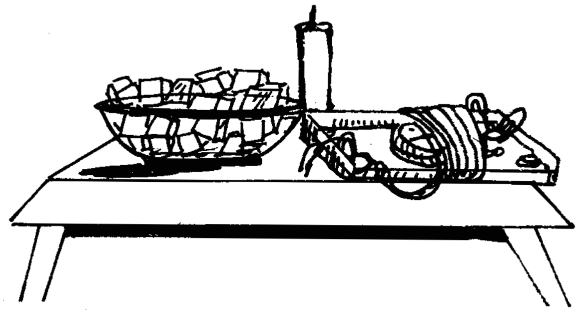
Try this

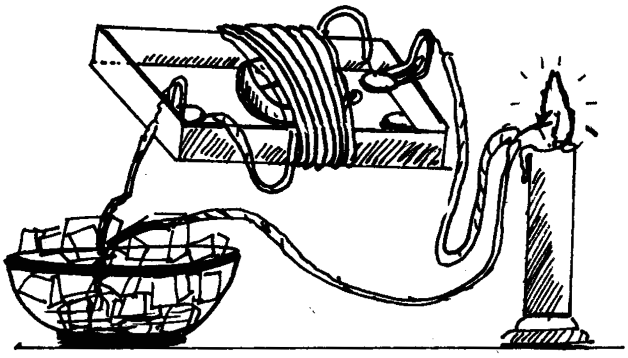
1. Clean two old coins made of different metals with steel wool or sand paper.
2. Fold some blotting paper into a pad, slightly larger than the coins.
3. Soak the blotting paper in salt water.
4. Place one coin under the pad and one on top. Hold them between your thumb and finger.
5. Connect both ends of the coil from your galvanometer to the coins. Watch the compass needle. What do you think makes the needle move?

Other Sources of Electricity
Thomas Seebeck discovered that electricity could be produced by using very hot and cold substances. When unlike metals are subjected to different temperatures, very hot and very cold, they produce electricity. This is called a **thermocouple.**

Try this with:

* a 1" length of insulated copper wire
* a 1" length of steel wire
* a bowl of ice
* a candle
* matches
* a galvanometer





1. Twist together tightly about 1" of the ends of the copper wire to the steel wire.
2. Cut the copper wire in half and attach the end of the copper wire to the galvanometer.
3. Light the candle.
4. Put one twisted end of the wires into the bowl of ice. Hold the other end in the candle flame. Does the galvanometer needle move? Remove the wire from either the flame or the ice, and watch the needle.

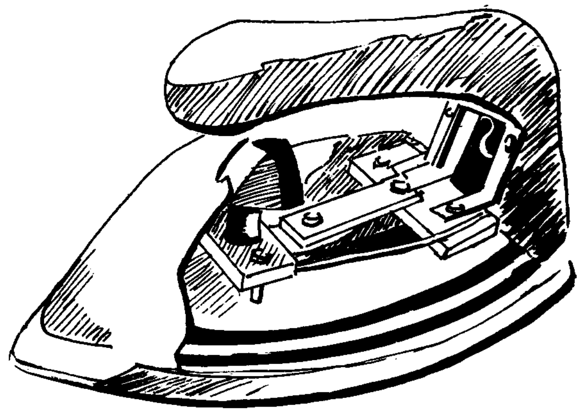
Electricity can also be obtaind from the sun's energy. This is done by **Solar Cells.**

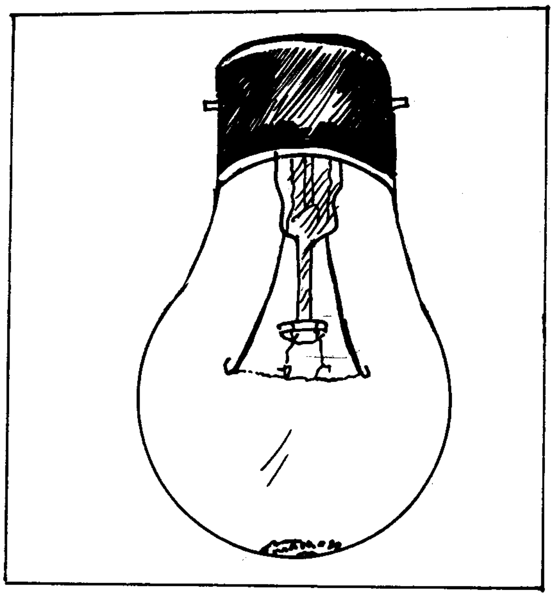
Seven
ELECTRIC GIFTS

From electrical energy we mainly get heat, light, motion and magnetism.

Heat and Light from Electricity
Electricity heats up things as it forces its way through them. The greater the resistance, the greater is the heat produced. Sometimes the conductor becomes warm, as in the case of an electric iron, sometimes red hot, as in a heater or a toaster, and at other times white hot, as in an electric bulb.

Long and thin wires made of special materials which have very large resistance are used to make heat. The wire is wound into a coil so that it takes less space. This is called a *heating coil* or an *element*.





Take a look at the heating coil of a heater.
Look carefully into a bulb. Is the wire inside the bulb different from that of the heater? What are the differences? Why do you think they are so?
When a heating coil becomes white hot, it emits light. The heating coil inside a bulb is called *a filament*. Filaments are usually made of tungsten. The advantage of tungsten is that it does not give so much heat as light.

Motion from Electricity

The type of motion directly obtained from electricity is rotation. When a current is passed through a coil which is placed in a magnetic field, the coil turns. This is the basic idea behind a *motor.*

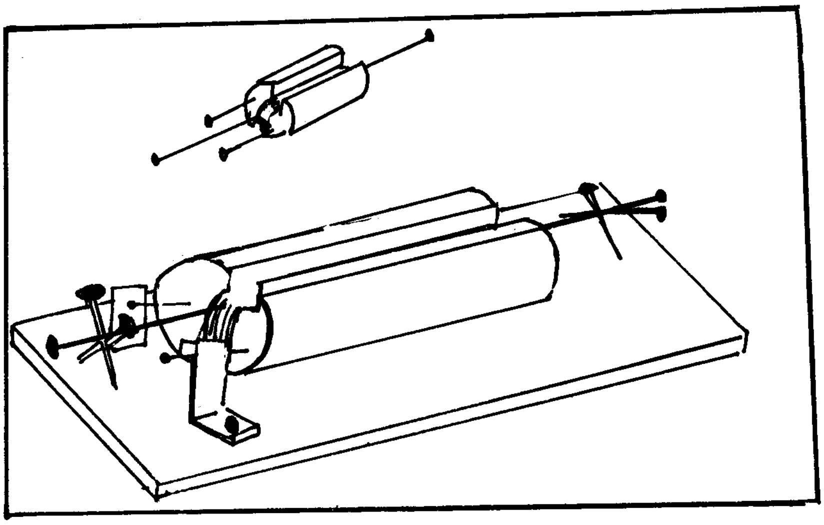
Electric motors have a wide variety of uses. It works household things like fans, pumps, coolers, vacuum cleaners, food processors, hair driers and electric shavers.

Motors are widely used in industries. Trains are run by motors.

Make Yourself a Motor

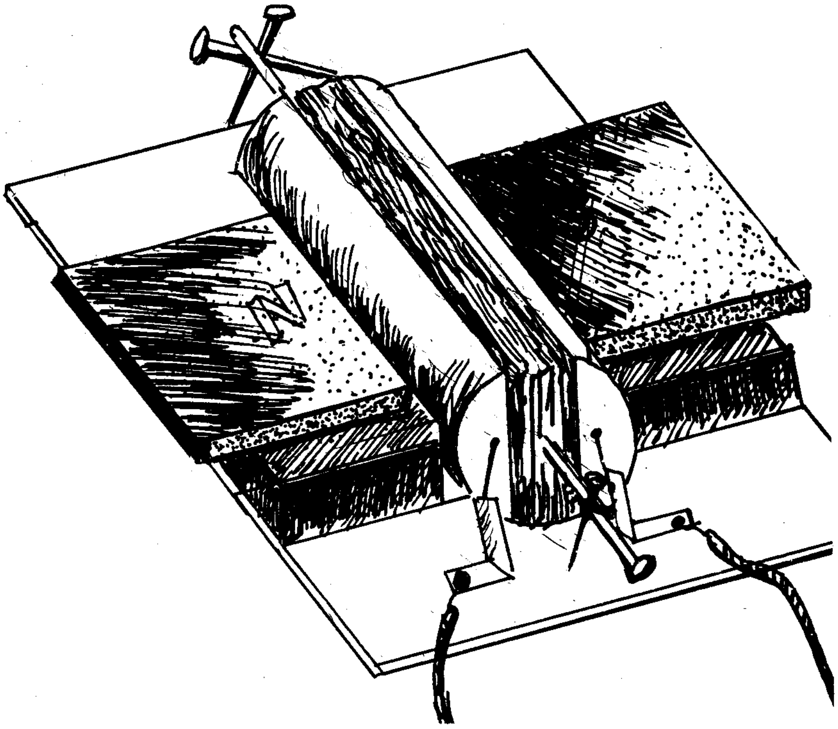
You will need:

* a large cork
* insulated copper wire
* a razor blade
* a knitting needle
* a wooden board
* nails
* tin foil
* board pins
* 2 bar magnets
* 2 empty matchboxes
* a 9-volt battery
* connecting wires



1. Cut a groove in the cork with the blade. Take help from an adult.
2. Wind 25 turns of the copper wire into the groove.
3. Remove insulation and wrap the ends of the wire to two nails fitted to the cork. These serve as terminals through which the current enters and leaves the coil.
4. Pass the knitting needle through the centre of the cork. This acts as an axle. Support the whole thing on two pairs of crossed nails mounted on a wooden board.
5. Cut out two thin tin foils and fix them to the board with board pins. The connecting nails of the coil should just touch these two tin plates when the cork is rotated.

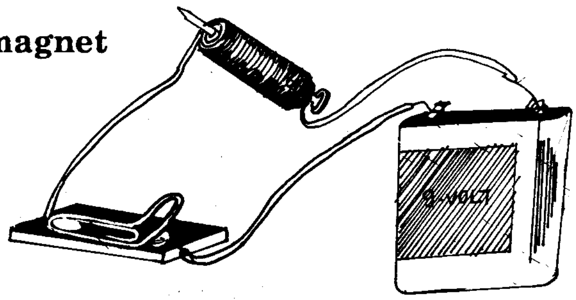
6. Put the magnets on the two match-boxes and place them on the two sides of the coil.
7. Connect the battery to the tin foils with connecting wires.
8. To start the motor, rotate the cork. It will keep on rotating.

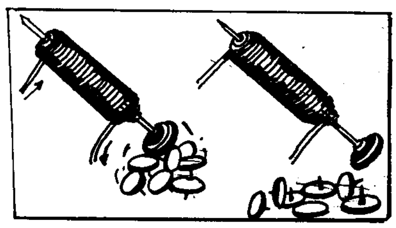


Magnetism from Electricity

Magnetism produced by an electric current is called electromagnetism. A magnet of this kind is called an *electromagnet*. Electromagnets have many uses, such as in electric cells, loudspeakers, electric motors and generators.

Make Yourself an Electromagnet





1. Wind 20 turns of a copper wire around a nail.
2. Connect the ends of the wire to a 9-volt battery through a switch, as shown.
3. Press the switch and bring some paper clips near the coil. What do you notice? The nail has turned into a magnet due to the current in the wire.

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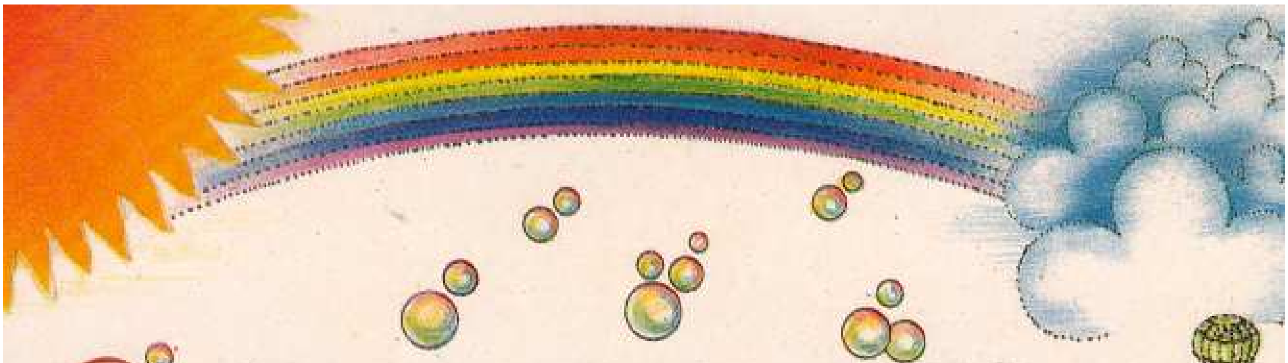

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Deepanwita Chattopadhyay has obtained an M.Tech. degree in electronics from the Institute of Radio Physics and Electronics, in Calcutta.

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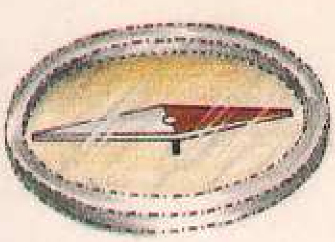

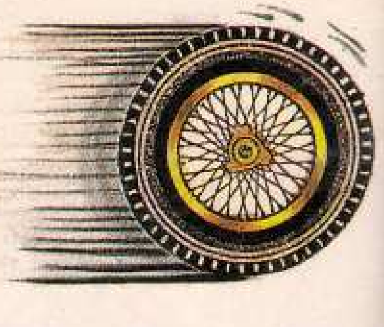

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